Amputations of Upper and Lower Extremities, Active and Reserve Components, U.S. Armed Forces, 2000-2011

Traumatic amputations of limbs profoundly alter the lives of affected service members. Service members are at risk for traumatic amputations of limbs during combat deployments as well as from other hazards such as motor vehicle accidents. From 2000 to 2011, there were 6,144 incident cases of traumatic amputations among 5,694 service members. Over one-third of these service members (n=2,037) had major amputations (i.e., loss of a hand or foot or more). Male, junior enlisted members of the Army and Marine Corps in combat-specific military occupations have been most affected by major amputations. Nearly two-thirds of major amputations occurred during a deployment or were deployment-related. Recent increases in numbers of major amputations generally reflect the extent and intensity of ground combat operations in Iraq and Afghanistan.

Traumatic amputations of limbs profoundly alter the lives of those affected and their families. In addition, combat-related amputations are often complicated by other life-threatening or life-changing conditions such as: traumatic brain injury (TBI); spinal cord and internal organ injuries; loss of hearing and visual acuity; heterotopic ossification; deep vein thrombosis/pulmonary embolus; chronic pain syndromes; post-traumatic stress disorder (PTSD) and many others.[1] The treatment and rehabilitation of amputations can be long and complicated; as such, care of traumatic amputees places significant burdens on the military and veterans' health systems.

Military members are at risk for minor (i.e., fingers, toes) and major (i.e., hands, arms, feet, legs) traumatic amputations during combat deployments and in many other settings. During the period of interest for this report, service members were frequently exposed to severe injury risk during combat operations in Iraq and Afghanistan. Because of improvements in protective equipment and innovations in medical evacuation procedures and battlefield trauma care (e.g., mobile trauma teams, triage procedures, forward deployment of multidisciplinary specialists) many severely injured service members, who might have died in earlier wars/conflicts, survived their injuries with significant disabilities, including amputations.[2-4] Service members are also at risk of non-combat related amputations resulting from motor vehicle, occupational, and recreational accidents (e.g., collisions, lacerations, falls, burns).

This report summarizes the numbers, types, and anatomic locations of minor and major traumatic amputations, and the demographic and military characteristics of active and reserve component members affected by them, from 2000 to 2011. The report also describes temporal trends and demographic and military characteristics of deployment-related amputations.

METHODS

The surveillance period was 1 January 2000 through 31 December 2011. The surveillance population consisted of all individuals who served in an active and/or reserve component of the U.S. Armed Forces at any time during the surveillance period. Diagnosis and procedure codes of the International Classification of Diseases, Ninth Revision, Clinical Modifications (ICD-9-CM) that specify injuries or treatments specific for amputations were used to identify traumatic amputations that occurred among service members during the surveillance period; the ICD-9-CM codes considered case-defining for this analysis are listed in Table 1.

The Defense Medical Surveillance System (DMSS) maintains electronic records of all hospitalizations and ambulatory visits of actively serving U.S. military members in U.S. military and civilian (contracted/purchased care through the Military Health System) medical facilities worldwide; the Theater Medical Data Store (TMDS) maintains records of medical encounters of service members deployed to southwest Asia/Middle East. For this analysis, the DMSS and the TMDS were searched to identify all medical encounter records that included one or more traumatic amputation-specific diagnostic and/or procedure codes. TMDS records were available only for calendar years 2005 through 2011.

For surveillance purposes, a case of traumatic amputation was defined as an individual with: 1) a hospitalization record with a case-defining ICD-9-CM diagnosis or procedure code in any diagnostic position; 2) an outpatient encounter record with a case-defining ICD-9-CM code in any diagnostic position, if the outpatient encounter occurred during a hospitalization; 3) two outpatient encounter records that included case-defining ICD-9-CM codes as their primary (first-listed) diagnoses – and at least one of the case-defining ICD-9-CM codes was an injury diagnosis (not a procedure or V-coded diagnosis). For all cases of major amputations identified through outpatient encounters alone (per definition 3), all relevant electronic medical encounter data were reviewed to confirm the presence of amputations (e.g., amputation-specific CPT codes and other non-case-defining but amputation-related codes). Finally, using TMDS data, a case was defined by any encounter with a non-V-coded case-defining amputation code in any diagnostic position **(Table 1)**.

For the purpose of summarizing the numbers and anatomical sites of amputations, each affected individual could be counted as both an incident upper

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
JUN 2012		**00-00-2012 to 00-00-2012**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Amputations of Upper and Lower Extremities, Active and Reserve Components, U.S. Armed Forces, 2000-2011	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Armed Forces Health Surveillance Center,11800 Tech Road, Suite 220 (MCAF-CS),Silver Spring,MD,20904**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
MSMR Vol. 19 No. 6 June 2012, See also ADA563931

14. ABSTRACT

Traumatic amputations of limbs profoundly alter the lives of aff ected service members. Service members are at risk for traumatic amputations of limbs during combat deployments as well as from other hazards such as motor vehicle accidents. From 2000 to 2011, there were 6,144 incident cases of traumatic amputations among 5,694 service members. Over one-third of these service members (n=2,037) had major amputations (i.e., loss of a hand or foot or more). Male, junior enlisted members of the Army and Marine Corps in combat-specifi c military occupations have been most aff ected by major amputations. Nearly two-thirds of major amputations occurred during a deployment or were deployment-related. Recent increases in numbers of major amputations generally reflect the extent and intensity of ground combat operations in Iraq and Afghanistan.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**6**	

TABLE 1. ICD-9-CM diagnostic and procedure codes for traumatic amputation

	ICD-9-CM		
	Diagnosis codes	Health status codes (V-codes)	Procedure code
Upper extremity			
Traumatic amputation of thumb (complete) (partial)[a]	885.x	V49.61	84.02
Traumatic amputation of other finger(s) (complete) (partial)[a]	886.x	V49.62	84.01
Amputation of hand/wrist[b]		V49.63, V49.64	84.03, 84.04
Traumatic amputation of arm and hand (complete) (partial)[b]			
Unilateral, below elbow	887.0, 887.1	V49.65	84.05
Unilateral, at or above elbow	887.2, 887.3	V49.66, V49.67	84.06-84.09
Bilateral (any level)	887.6, 887.7		
Lower extremity			
Traumatic amputation of toe(s) (complete) (partial)[a]	895.x	V49.71, V49.72	84.11
Traumatic amputation of foot - unilateral (complete) (partial)[b]			
Unilateral (complete) (partial)	896.0, 896.1	V49.73, V49.74	84.12-84.14
Bilateral	896.2, 896.3		
Traumatic amputation of leg(s) (complete) (partial)[b]			
Unilateral, below knee	897.0, 897.1	V49.75	84.15
Unilateral, at or above knee	897.2, 897.3	V49.76, V49.77	84.16- 84.19
Bilateral (any level)	897.6, 897.7		
Unspecified[a]			
Upper limb, unilateral, unspecified	887.4-887.5	V49.6, V49.60	84.0, 84.00
Lower limb, unilateral, unspecified	897, 897.4, 897.5	V49.7, V49.70	84.1, 84.10

[a]Minor amputation
[b]Major amputation

extremity case and/or an incident lower extremity case once during the surveillance period. Summaries of anatomic locations were based on the most proximal site per extremity per individual and the most severe injury (i.e., bilateral prioritized over unilateral) that was reported during the surveillance period. Furthermore, inpatient encounters were prioritized over outpatient encounters, and diagnoses reported from deployed settings (TMDS data) were prioritized over those reported from nondeployed settings (DMSS data).

For purposes of summarizing demographic and military characteristics, an individual could be considered a case only once during the surveillance period regardless of the number of encounters for amputations per individual. Individuals were excluded if they had a case-defining amputation code prior to the surveillance period in either inpatient or outpatient encounters.

Causes of amputations were assessed based on E-codes (ICD-9-CM-based supplemental external cause of injury codes) reported during inpatient and outpatient encounters and STANAG codes (per NATO Standard Agreement No. 2050) reported on the record of each case-defining hospitalization in a U.S. military medical facility.

Deployment-related amputations: For the purposes of this analysis, a service member with a deployment-related amputation was defined as an individual with a major amputation that occurred during a deployment period or had a war- or battle-related cause of injury code listed on the record of an amputation-specific encounter. Service members with other or unknown causes of amputations were combined into an "other" group and used for comparison purposes.

RESULTS

During the surveillance period, there were 6,144 incident cases of traumatic amputation among 5,694 service members **(Table 2)**. A majority of all amputation-related injuries were considered minor amputations (i.e., toes, fingers, thumbs, upper/lower unspecified) (n=3,849; 63%). There were 2,295 major amputations (i.e., hands, feet, arms, legs) among 2,037 affected individuals; of these, 29 were bilateral upper extremity amputations and 360 were bilateral lower extremity amputations **(Table 2, Figures 1, 2)**.

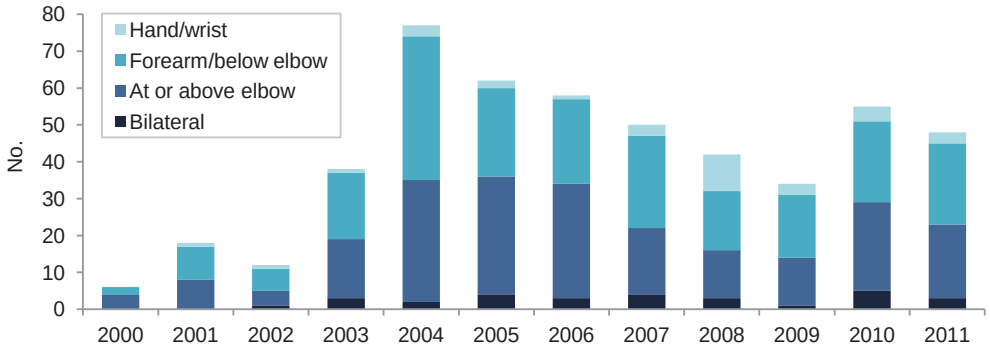
Of the upper extremity amputations (n= 3,839), a majority were minor amputations (n= 3,339; 87%). Of the major upper extremity amputations (n=500), there were 32 amputations that occurred at the hand/wrist, 223 of the forearm or below the elbow, 216 at or above the elbow, and 29 bilateral **(Figure 1)**. During the surveillance period the number of major upper extremity amputations increased from six in 2000 to a high of 77 in 2004. From 2005 to 2009, the number slightly decreased each year, then increased again in 2010 and 2011. Each year the greatest proportion of major upper extremity amputations occurred at a level more proximal than at the hand/wrist. Annual numbers of bilateral upper extremity amputations were relatively low and stable throughout the period (range, per year: 0 [2000, 2001] to 5 [2010]) **(Figure 1)**.

Of the lower extremity amputations (n=2,305), 22 percent were minor amputations (n=510) **(Table 2)**. A majority of lower extremity amputations were major amputations (n=1,795, 78%); of these, 135 were at the foot/ankle, 818 were below the knee, 482 were at/above the knee to the hip, 21 were bilateral foot/ankle, and 339 were bilateral leg amputations **(Table 2, Figure 2)**. During the surveillance period, the number of major lower extremity amputations increased from 22 in 2000 to 226 in 2007, decreased in 2008 and 2009, and then increased to 313 in 2011, the highest yearly

TABLE 2. Distribution of upper and lower extremity amputations by anatomical location, active and reserve component, U.S. Armed Forces, 2000-2011

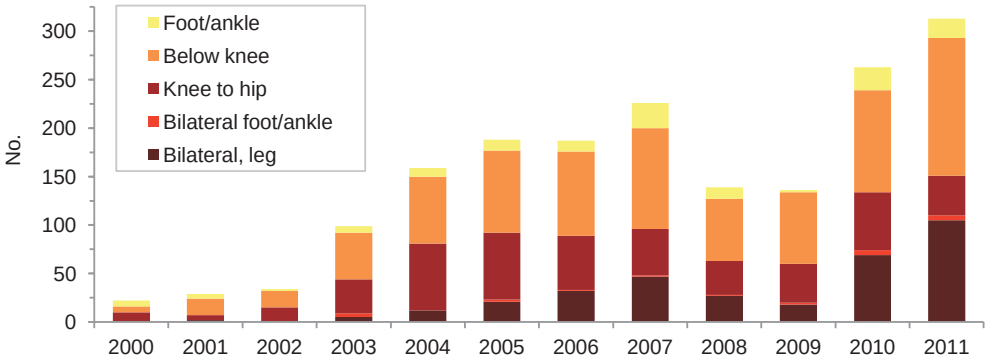
	Minor lower	Major lower	No lower	Total
Minor upper	29	148	3,162	3,339
Major upper	15	258	227	500
No upper	466	1,389	.	1,855
Total	510	1,795	3,389	5,694

FIGURE 1. Number of major upper body amputations by anatomical location, active and reserve components, U.S. Armed Forces, 2000-2011



[a]Excludes fingers, thumbs, and unspecified amputations

FIGURE 2. Number of major lower body amputations by anatomical location, active and reserve components, U.S. Armed Forces, 2000-2011



[a]Excludes toes and unspecified amputations

count during the period **(Figure 2)**. The number of bilateral lower extremity amputations increased from 2002 to 2007, then increased again in 2010 and 2011. In 2011, there were 110 bilateral lower extremity amputations, the most in any year of the surveillance period.

Of the 5,694 service members with an amputation, 450 (7.9%) had both upper and lower extremity amputations; 258 had two major extremity amputations (4.5%); 163 had one major and one minor amputation (2.9%); and 29 had two minor amputations (0.50%) **(Table 2)**. Twelve service members had both bilateral upper and bilateral lower amputations **(data not shown)**.

Overall, there were 2,037 service members with at least one major amputation. These individuals were more likely to be active component members (n=1,728; 84.8%), males (n=1,977; 97.1%), aged 20-24 (n=938;46.0%), white, non-Hispanic (n=1,516; 74.4%), in the Army (n=1,245; 61.1%), in the junior enlisted grades (E1-E4) (n=1,101; 54.1%), and in the infantry/artillery/combat engineering occupational category (n=1,089; 53.5%) than in the respective other military/demographic subgroups **(Table 3)**.

From 2005 to 2010, the proportion of service members affected by amputations who were in the active component increased from 75.8 percent to 90.1 percent **(data not shown)**. Consistently during the same period, there were many more major amputations among members of the Army and Marine Corps than the other services **(Figure 3)**. Of note, from 2009 to 2011, numbers and proportions of major amputations sharply increased among Marine Corps members; as a result, in contrast to recent prior experience, in 2011 there were more major amputations among members of the Marine Corps (n=157, 47.4% of the total) than the Army (n=146, 44.0% of the total) **(Figure 3)**.

Between 2009 and 2011, numbers and proportions of major amputations among junior enlisted (E1-E4) service members also markedly increased (2009: n=75 [48.1% of total]; 2011: n=203 [61.1% of total]) **(Figure 4)**.

Over the entire 12-year surveillance period, there were more amputations among service members in the "infantry, general" (n=728; 35.7%) than any other specific military occupational group **(data not shown)**. From 2005 to 2011, more than 40 percent of all amputations occurred among service members in combat-specific (infantry/artillery/combat engineering) occupations; in 2010 and 2011, nearly 70 percent of amputations affected service members in combat-specific occupations **(Figure 5)**.

Of the 2,037 service members with a major amputation, 52.8 percent (n=1,075) had an external cause of injury code associated with the amputation encounter. Over one-third of all service members with a major amputation had an external cause of injury indicating "battle injury" (n=694; 34.1%); 11.1 percent (n=227) had a code indicating "guns and explosives" (accident or undetermined intent); and 5.9 percent (n=120) had a code indicating "motor vehicle accident" **(data not shown)**.

Deployment-related amputations

Nearly two-thirds (66.1%; n=1,347) of all service members with major extremity amputations were likely injured during deployments, i.e., the traumatic amputation occurred during a deployment or had a cause of injury code indicative of a deployment-related injury **(Table 3)**. During the surveillance period, the number of deployment-related amputations increased from 2001 (n=1) to 2007 (n=178), decreased in 2008 and 2009, then increased again in 2010 (n=202) and 2011 (n=248) **(Figure 6)**.

EDITORIAL COMMENT

This report summarizes annual numbers and types of minor and major traumatic amputations in active and reserve component service members from 2000 through 2011. The report also compares experiences regarding upper and lower major extremity amputations, overall and in relation to various demographic and military characteristics. Notably, the report documents

TABLE 3. Demographic and military characteristics of service members with major extremity amputations, active and reserve component, U.S. Armed Forces, 2000-2011

	Deployment-related		Other		Total	
	No	% total	No	% total	No	% total
Total	1,347	.	690	.	2,037	.
Active	1,176	87.3	552	80.0	1,728	84.8
Reserve/Guard	171	12.7	138	20.0	309	15.2
Sex						
Female	24	1.8	36	5.2	60	2.9
Male	1,323	98.2	654	94.8	1,977	97.1
Age Group						
<20	63	4.7	35	5.1	98	4.8
20-24	685	50.9	253	36.7	938	46.0
25-29	340	25.2	151	21.9	491	24.1
30-34	139	10.3	75	10.9	214	10.5
35-39	87	6.5	73	10.6	160	7.9
>39	33	2.4	103	14.9	136	6.7
Race-ethnicity						
White, non-Hispanic	1,035	76.8	481	69.7	1,516	74.4
Black, non-Hispanic	95	7.1	109	15.8	204	10.0
Hispanic	141	10.5	47	6.8	188	9.2
Asian/Pacific Islander	37	2.7	22	3.2	59	2.9
Other	39	2.9	31	4.5	70	3.4
Service						
Army	893	66.3	352	51.0	1,245	61.1
Navy	32	2.4	137	19.9	169	8.3
Air Force	25	1.9	89	12.9	114	5.6
Marine Corps	397	29.5	106	15.4	503	24.7
Coast Guard	0	0.0	6	0.9	6	0.3
Grade						
E1-E4	774	57.5	327	47.4	1,101	54.1
E5-E9	481	35.7	284	41.2	765	37.6
O1-O3&WO1-WO3	84	6.2	46	6.7	130	6.4
O4-O10&WO3-WO5	8	0.6	33	4.8	41	2.0
Occupation						
Armor/motortransport	93	6.9	37	5.4	130	6.4
Infantry/artillery/combateng	912	67.7	177	25.7	1,089	53.5
Comm/intel	129	9.6	124	18.0	253	12.4
Repair/engineer	75	5.6	169	24.5	244	12.0
Healthcare	44	3.3	54	7.8	98	4.8
Pilot/aircrew	9	0.7	13	1.9	22	1.1
Other	85	6.3	116	16.8	201	9.9

trends over the past 12 years with particular emphasis on the last two years.

Not surprisingly, the report documents relatively large numbers of major extremity amputations during periods of more widespread and intense ground combat operational activities – initially in Iraq and more recently in Afghanistan. For example, there were relatively large numbers of major upper extremity amputations in 2004 through 2006 and again in 2010 and 2011 and of major lower extremity amputations from 2003 to 2007 and again in 2010 and 2011. Of particular note, in 2010 and 2011, there were sharp increases in lower extremity amputations – particularly among junior enlisted members of the Marine Corps and Army serving in combat-specific military occupations (i.e., infantry, artillery, combat engineering). The experience generally reflects the recent surges in the extent and intensity of ground combat operations in Afghanistan.

There are several limitations to the report that should be considered when interpreting the results. For example, the ICD-9-CM diagnosis and procedure codes used to identify traumatic amputation do not specify limb laterality (i.e., right or left side of the body) or surgical revisions of prior amputations. Thus, it is often difficult to determine if a new encounter with a code for amputation represents re-documentation of a known injury, a surgical revision of a previous amputation (at the same level or more proximal), or a new amputation on the opposite side of the body from the previously recorded injury.

FIGURE 3. Number and proportion of service members with major extremity amputation by service, active and reserve components, U.S. Armed Forces, 2005-2011

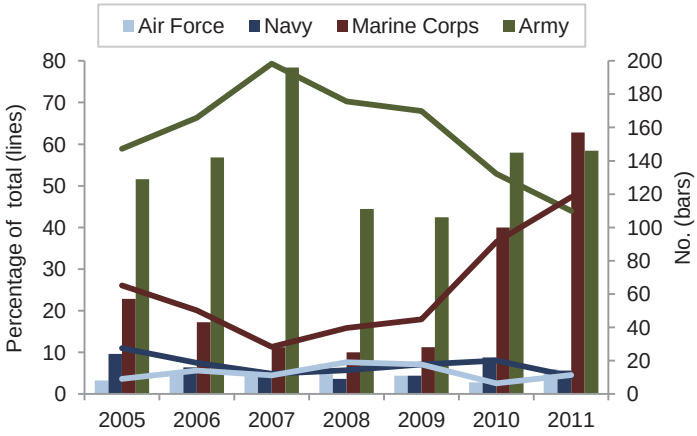


FIGURE 4. Number and proportion of service members with major extremity amputation by grade, active and reserve components, U.S. Armed Forces, 2005-2011

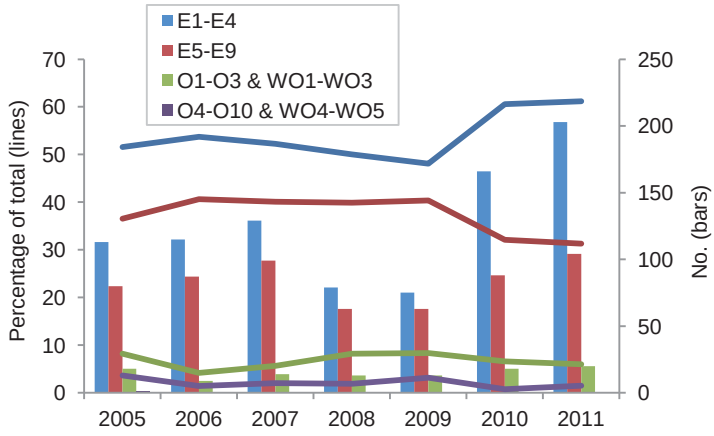
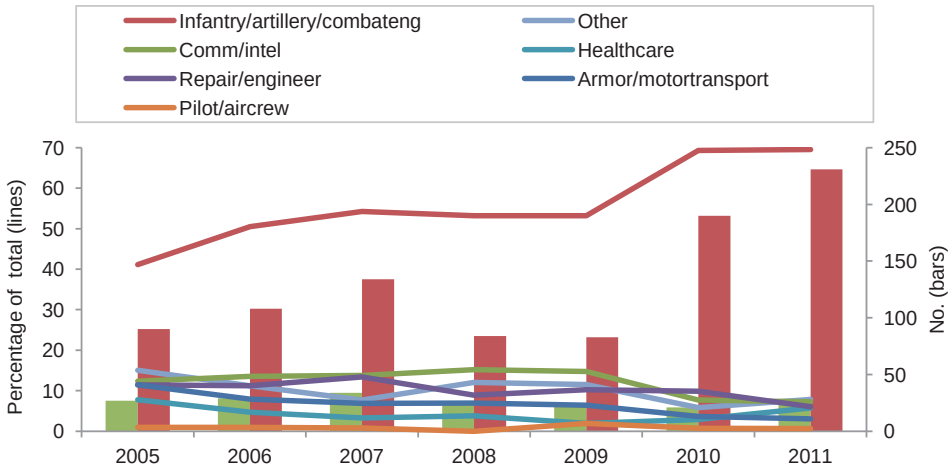


FIGURE 5. Number[a] and proportion of service members with major extremity amputation by military occupation, active and reserve components, U.S. Armed Forces, 2005-2011

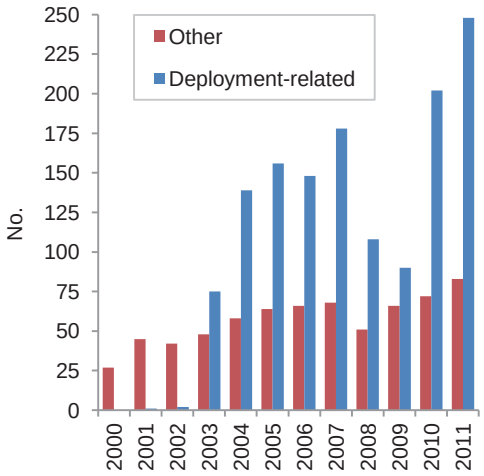


[a]Number shown for infantry/artillery/combateng and comm/intel only (for comparison purposes)

Furthermore, the assignment of anatomical location and severity (i.e., minor, major) were estimated based on ICD-9 codes which can be imprecise and ambiguous. For example, the codes that specify "bilateral amputations" do not indicate the anatomic locations of the amputations. Thus, the anatomical locations and severity (e.g., toe vs. leg, finger vs. arm) of the bilateral amputations reported here remain unclear.

The current case definition was repeatedly refined to optimize the sensitivity of the case finding algorithm while preserving the specificity of the surveillance case definition. To this end, the electronic medical records of a sample of potential cases were reviewed in detail to assess the numbers, timing, and natures of follow-up encounters, outpatient procedures (per common procedure codes [CPT]), and other amputation-related experiences.

FIGURE 6. Number of major amputations by deployment-related and "other," active and reserve components, U.S. Armed Forces, 2005-2011



Traumatic amputations – especially when combat-related – are often associated with life-threatening comorbid conditions. In such cases, the life-threatening conditions may take precedence in reporting of diagnoses, and/or amputations may be inaccurately or not specifically reported, on standardized medical encounter records. For example, if a service member was gravely injured, and an amputation was not reported in one of the available diagnostic positions on the standardized record of the related hospitalization, the encounter would not be identified as a case-defining event (unless amputation-specific procedure codes or contemporaneous outpatient diagnoses were recorded). Also, some severely injured service members may receive care outside of the Military Health System (e.g., civilian trauma centers, Veterans Health Administration hospitals); in such cases, amputations may not be documented on records used for this analysis. In summary, some amputations may not have been identified by the automated screening of administrative medical encounter records using the surveillance case definition developed for this report.

Finally, assessments of the causes of amputations and their relationships to deployment were based on cause of injury codes and routinely collected deployment-related information. Because such data sources are incomplete and potentially inaccurate (e.g., exact start and end dates of deployments), there are undoubtedly misclassifications of relationships between amputations and deployment statuses. In addition, deployment-related amputations are not necessarily "combat-related"; for example, severe injuries unrelated to combat can occur during periods of deployment (e.g., motor vehicle accidents in theater or while on leave outside of theater).

In summary, since 2003, many traumatic amputations among U.S. service members have occurred during combat-related activities in Iraq and Afghanistan. Male, junior enlisted members of the Army and Marine Corps in combat-specific military occupations have been most affected. Numbers and types of amputations generally reflect the extent and intensity of ground combat operations in Iraq and Afghanistan. Improvements in protective equipment, medical evacuation procedures, and in theater trauma care improve the survivability of previously lethal combat-related injuries. In turn, there are increasing demands for multidisciplinary treatment and rehabilitative care for wounded warriors with upper and/or lower extremity amputations and other complex medical, surgical, and psychological conditions.

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